

What is claimed is:

1. A method for closure of an opening in a tissue membrane located beneath the skin of a patient, the tissue membrane having a distal side and a proximal side, comprising the steps of:

providing a tubular member having a lumen therein beneath the skin of the patient and in close proximity to the opening in the tissue membrane;

inserting a first, distal end of a retrieval assembly through said lumen and past the opening to a location on the distal side of the tissue membrane;

providing needle means for penetrating through the tissue membrane and for carrying at least two lengths of suture material from the proximal side to the distal side of the tissue membrane;

advancing said needle means through the tissue membrane from the proximal side to the distal side of the tissue membrane adjacent but spaced from the opening at two separate suture locations, the needle means carrying the suture material through the tissue membrane at the two separate suture locations;

grabbing the suture material with the distal end of said retrieval assembly at the location on the distal side of the tissue membrane; ..

retrieving said suture material through the opening by withdrawing the distal end of said retrieval assembly out through the opening; and,

drawing the suture locations together with said suture material passing through the suture locations.

2. The method of claim 1 and further comprising the step of: expanding the distal end of said retrieval assembly on the distal side of the tissue membrane after said inserting step.

3. The method of claim 2 and further comprising the step of: urging the expanded distal end of said retrieval assembly toward the opening and into contact with the tissue membrane prior to said step of advancing the needle means.

4. The method of claim 4 in which the needle means includes a plurality of needles having needle tips for penetrating through the membrane, said method further comprising the steps of:

removing a shield from over the needle tips to expose the needle tips; and moving the needles from a compact mode to a deployed mode prior to said step of advancing the needle means.

5. The method of claim 4 wherein said retrieving step further includes withdrawing the distal end of said retrieval assembly and the suture material through the lumen of said tubular member.

6. The method of claim 5 wherein said step of grabbing the suture material includes the step of rotating means for grabbing the suture at the distal end of said retrieval assembly on the distal side of the tissue membrane after said step of advancing the needle means.

7. The method of claim 6 and further comprising the steps of: withdrawing the needle means from the tissue membrane; moving the needles back to the compact mode; shielding the tips of the needles; and, withdrawing the needle means and the tubular member from the patient, wherein said withdrawing step occurs prior to said step of drawing together said suture locations.

8. The method of claim 7 and further comprising the steps of: threading a first suture between a first suture location and a second suture location, said threading step including the steps of providing a second suture through the second suture location, the second suture forming a loop, inserting the first suture through the loop of the second suture, and thereafter pulling the loop along with the first suture through the second suture location, said threading step occurring prior to said step of drawing together the suture locations.

9. The method of claim 8 wherein the tissue membrane is a blood vessel and wherein the opening is an opening formed by catheterization of the blood vessel, and wherein said step of inserting a distal end of the retrieval assembly occurs after a cardiovascular catheterization procedure.

10. The method of claim 1 wherein said retrieving step further includes withdrawing the distal end of said retrieval assembly and the suture material through the lumen of said tubular member.

11. The method of claim 1 wherein said step of grabbing the suture material includes the step of rotating means for grabbing the suture at the distal end of said retrieval assembly on the distal side of the tissue membrane after said step of advancing the needle means.

12. The method of claim 1 and further comprising the steps of: threading a first suture between a first suture location and a second suture location, said threading step including the steps of providing a second suture through the second suture location, the second suture forming a loop, inserting the first suture through the loop of the second suture, and thereafter pulling the loop along with the first suture through the second suture location, said threading step occurring prior to said step of drawing together the suture locations.

13. The method of claim 1 wherein the tissue membrane is a blood vessel and wherein the opening is an opening formed by catheterization of the blood vessel, and wherein said step of inserting a distal end of the retrieval assembly occurs after a cardiovascular catheterization procedure.

14. An apparatus for providing sutures through a tissue membrane located beneath the skin of a patient, the tissue membrane having a distal side and a proximal side, the sutures extending through the membrane at locations positioned around an opening in the tissue membrane, comprising:

a tubular body having a side wall defining a lumen therein, said tubular body having a portion thereof extendable through the opening and beyond the distal side of the tissue membrane to allow introduction of material into the patient through the lumen beyond the tissue membrane;

an array of at least two needles disposed around said tubular body, said needles carrying a respective length of suture, said needles being advanceable through the tissue membrane from the proximal side to the distal side to provide suture material at separate suture locations in the tissue membrane around the opening.

15. The apparatus of claim 14 and further comprising a needle shield received about said tubular body allowing selective shielding and exposing of said needles, said tubular body being advanceable with said shield in a first position shielding said needles, said shield being selectively movable to a second position to expose said needles in an array around the opening in the tissue membrane.

16. The apparatus of claim 15 and further comprising a retrieval assembly having an elongated portion with a first distal end disposable through the lumen and through the opening in the tissue membrane, the first end being adapted to grab suture material at a location on the distal side of the tissue membrane.

17. The apparatus of claim 16 and further comprising a valve body located in the lumen, wherein said valve body has a collapsible opening therethrough allowing insertion and removal of medical devices, such as catheters, therethrough while providing a fluid seal of the lumen.

18. The apparatus of claim 17 wherein said needles are movable from a compact mode to a deployed mode radially away from said tubular member, said needles in said compact mode being shieldable by said needle shield, said needles in said deployed mode having needle tips exposed.

19. The apparatus of claim 18 wherein each of said needles has a distal end including a respective needle tip, a proximal end, and a central portion therebetween, wherein the central portion of each of said needles defines a respective longitudinal pivot axis, the distal end and the proximal end of said needles each being eccentric to the respective longitudinal pivot axis, and wherein rotational movement of the proximal end of each of said needles causes a respective central portion to move to cause the respective distal end of each of said needles to move between the compact mode and the deployed mode.

20. The apparatus of claim 19 wherein the distal end of said retrieval assembly includes:

at least one flexible outer bow member having a distal end, a proximal end, and a central portion between said distal end and said proximal end, the proximal end of the bow member being attached to the elongated portion of said retrieval assembly;

a tension member attached to the distal end of the bow member, said tension member and the proximal end being selectively movable with respect to each other to urge the distal end and the proximal end toward each other, causing the central portion of said bow member to deflect outwardly away from said tension member to receive suture material, said tension member and the proximal end

also being selectively movable with respect to each other to urge the distal end and the proximal end apart from each other, causing the central portion of said bow member to deflect inwardly toward said tension member in a collapsed position to secure suture at the distal end, the first end in the collapsed position being sized to be withdrawn through the lumen; and,

grabbing means for grabbing suture when said outer bow member is deflected outwardly.

21. The apparatus of claim 20 wherein the first end of said retrieval assembly further includes:

a plurality of flexible outer bow members disposed around said tension member and having distal ends connected thereto, said bow members further having proximal ends attached to the elongated portion of said retrieval assembly; and

wherein said grabbing means comprises a rotating member positioned within said outer bow members.

22. The apparatus of claim 14 and further comprising a retrieval assembly having an elongated portion with a first end disposable through the lumen and through the opening in the tissue membrane, wherein the first end is adapted to grab suture at a location on the distal side of the tissue membrane.

23. The apparatus of claim 14 and further comprising a valve body located in the lumen, wherein said valve body has a collapsible opening therethrough allowing insertion and removal of medical devices, such as catheters, therethrough while providing a fluid seal of the lumen.

24. The apparatus of claim 14 wherein said needles are movable from a compact mode to a deployed mode radially away from said tubular member.

25. The apparatus of claim 24 wherein each of said needles has a distal end including a respective needle tip, a proximal end, and a central portion therebetween, wherein the central portion of each of said needles defines a respective longitudinal pivot axis, the distal end and the proximal end of said needles each being eccentric to the respective longitudinal pivot axis, and wherein rotational movement of the proximal end of each of said needles causes a respective central portion to move to cause the respective distal end of each of said needles to move between the compact mode and the deployed mode.

26. The apparatus of claim 22 wherein the distal end of said retrieval assembly includes:

at least one flexible outer bow member having a distal end, a proximal end, and a central portion between said distal end and said proximal end, the proximal end of the bow member being attached to the elongated portion of said retrieval assembly;

a tension member attached to the distal end of the bow member, said tension member and the proximal end being selectively movable with respect to each other to urge the distal end and the proximal end toward each other, causing the central portion of said bow member to deflect outwardly away from said tension member to receive suture material, said tension member and the proximal end also being selectively movable with respect to each other to urge the distal end and the proximal end apart from each other, causing the central portion of said bow member to deflect inwardly toward said tension member in a collapsed

position to secure suture at the distal end, the first end in the collapsed position being sized to be withdrawn through the lumen; and,

grabbing means for grabbing suture when said outer bow member is deflected outwardly.

27. The apparatus of claim 26 wherein the first end of said retrieval assembly further includes:

a plurality of flexible outer bow members disposed around said tension member and having distal ends connected thereto, said bow members further having proximal ends attached to the elongated portion of said retrieval assembly; and

wherein said grabbing means comprises a rotating member positioned within said outer bow members.

28. An apparatus for retrieving suture, comprising:

a retrieval assembly having an elongated portion with a first distal end, wherein the first end includes:

at least one flexible outer bow member having a distal end, a proximal end, and a central portion between said distal end and said proximal end, the proximal end of the bow member being attached to the elongated portion of said retrieval assembly;

a tension member attached to the distal end of the bow member, said tension member and the proximal end being selectively movable with respect to each other to urge the distal end and the proximal end toward each other, causing the central portion of said bow member to deflect outwardly away from said tension member to receive suture material, said tension member and the proximal end also being selectively movable with respect to each other to urge the distal end

and the proximal end apart from each other, causing the central portion of said bow member to deflect inwardly toward said tension member in a collapsed position to secure suture at the distal end, the first end in the collapsed position being sized to be withdrawn through a catheter lumen; and,

grabbing means for grabbing suture when said outer bow member is deflected outwardly.

29. The apparatus of claim 28 wherein the first end of said retrieval assembly further includes:

a plurality of flexible outer bow members disposed around said tension member and having distal ends connected thereto, said bow members further having proximal ends attached to the elongated portion of said retrieval assembly; and

wherein said grabbing means comprises a rotating member positioned within said outer bow members.

30. The apparatus of claim 29 wherein said retrieval assembly further includes:

a first handle member secured to a proximal end of the elongated portion of said retrieval assembly; and,

a second handle member movable with respect to said first handle member, wherein said tension member connected to said bow members is elongated and is secured to said second handle member, and wherein movement of said second handle member and said first handle member with respect to each other causes expansion and contraction of the first end.

31. The apparatus of claim 30 wherein the first end of said rotating member includes at least one serrated edge for snagging suture.

32. The apparatus of claim 31 wherein the first end of said retrieval assembly further includes:

a seal member along a proximal base of said distal end to provide a seal against outflow of fluid through an opening in a tissue membrane.

33. The apparatus of claim 28 wherein the first end of said retrieval assembly further includes:

a seal member along a proximal base of said distal end to provide a seal against outflow of fluid through an opening to be sutured closed.

34. The apparatus of claim 28 wherein the first end of said retrieval assembly further includes:

at least one member having a serrated edge between said bow member and said tension member for snagging suture.

35. The apparatus of claim 28 wherein the first end of said retrieval assembly further includes:

an elastomeric membrane expandable on the distal side of an opening in a tissue membrane, wherein said elastomeric membrane receives at least one needle carrying suture pierced therethrough, and wherein upon withdrawal of the needle from the elastomeric membrane the suture remains pierced through

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said elastomeric membrane for withdrawal of the elastomeric membrane and suture together through the opening in the tissue membrane.

36. The apparatus of claim 28 wherein the first end of said retrieval assembly further includes:

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a surface having hook means for hooking nap formed by suture material, the hook means and suture material together being removable through the opening in the tissue membrane.